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Abstract: This paper reviews the methods of which a laser architecture can modulate the properties of light, specifically polarization and intensity.

INTRODUCTION

Light modulation is an essential tool applied in many modern technologies and fields such as displays and communications. There are many properties of light that can be modulated, such as polarity, phase, amplitude, timing, and intensity[1]. The following figure is a conceptual design of a laser architecture that modulates all of these properties, thus delivering programmable light bullets[1]. Within the design lies control units capable of changing the polarity and intensity of the light beam that passes through[1].

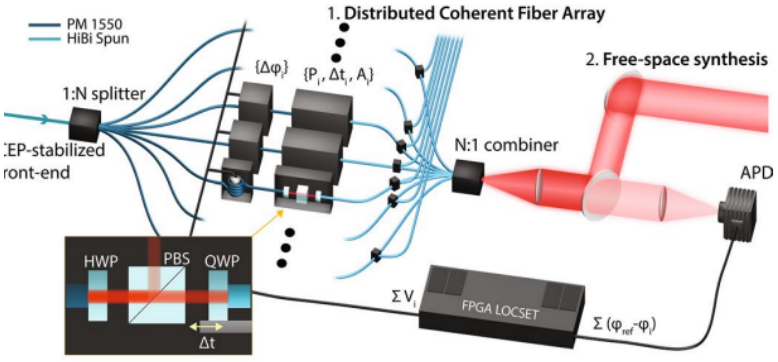

Fig. 1. Laser architecture with multi-channel fiber array feeding into control units[1].

METHODS

A control unit is made up of a half-wave plate, polarizing beam splitter, and quarter-wave plate[1]. The half-wave plate and quarter-wave plate are made up of an anisotropic material. The thickness of the material, given by Eq. 1 and Eq. 2, determine the classification.

$$l_{\frac{\lambda}{2}} = \frac{1}{2}\frac{\lambda}{|n_y - n_x|} \quad (1)$$

$$l_{\frac{\lambda}{4}} = \frac{1}{4}\frac{\lambda}{|n_y - n_x|} \quad (2)$$

The polarizing beam splitter splits the incident light beam into two output beams. Eq. 3 represents the conservation of energy[2].

$$I_{out,1} = I_{in} - I_{out,2} \quad (3)$$

RESULTS AND INTERPRETATION

An anisotropic material with a designed thickness exploits the phenomena of birefringence to change the polarization of light passing through. With a half-wave plate, the component of the polarization orientated by the fast axis is advanced by 180 degrees relative to the component of the slow axis[2]. The output remains linearly polarized, but rotated by any amount depending on the angle between the incident polarization and fast axis[2].

With a quarter-wave plate, the component of the polarization orientated by the fast axis is advanced by 90 degrees relative to the component of the slow axis[2]. The output becomes circularly or elliptically polarized depending on the angle between the incident polarization and fast axis[2]. The result is a phase difference between axes and any desired polarization.

The beam splitter can be designed with any reflectance/transmittance ratio so that the intensity of the output beam may be reduced by the amount split[2].

CONCLUSIONS

By modulating properties such as polarization and intensity, the laser architecture can configure an array of light beams each in deliberate ways. Each beam can carry a unique signal or be combined to exploit its topology. From communication to optical tweezers, there continue to be many implications of light modulation in today's technology.

REFERENCES

1. Lemons, R., Liu, W., Frisch, J.C. *et al.* Integrated structured light architectures. *Sci Rep* 11, 796 (2021). https://doi.org/10.1038/s41598-020-80502-y
2. Liu, Jia-Ming. *Principles of Photonics*. Cambridge University Press, 2017.